CHEMICAL & ENGINEERING NEWS

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C&EN

SEPTEMBER 14, 1992

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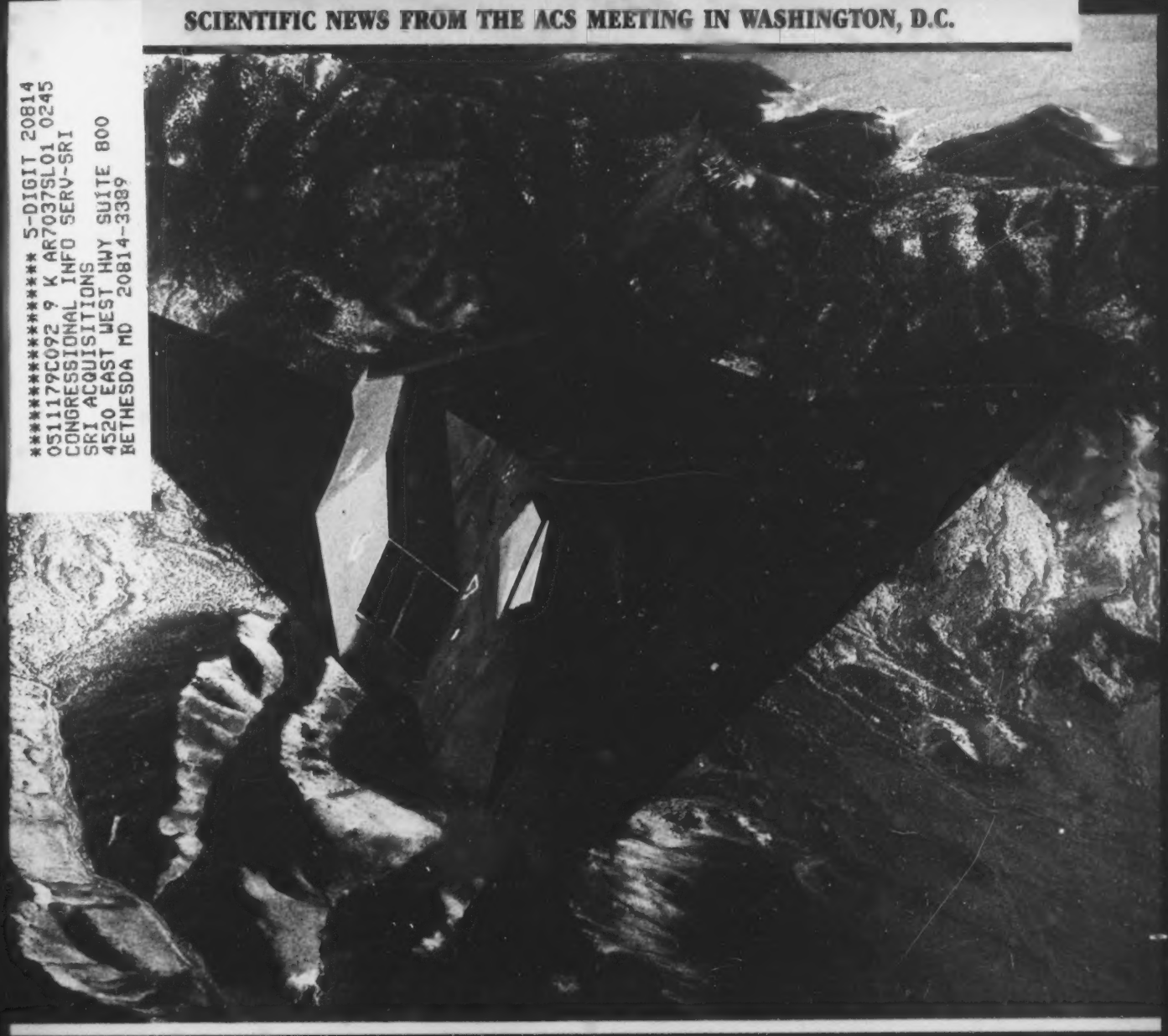

DARPA

Key defense research agency probes limits of the possible

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CHEMICAL & ENGINEERING NEWS

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NEWS OF THE WEEK

■ Neilsbohrium, hassium, and meitnerium are formally proposed as names for heavy elements 107, 108, 109, but naming procedure and names of other heavy elements are causing controversy. Page 4

■ Dow Chemical announces executive changes. Paul Oreffice will retire in December, Frank Popoff will succeed him as chairman, and, next April, William Stavropoulos will follow Popoff as president. Page 5

■ Two Texas companies consider building major chemical plants in Mexico—one to produce methyl *tert*-butyl ether and another to make linear alkylbenzene. Page 6

■ Joan Shields withdraws from ACS Board election, leaving a field of four candidates for the two available director-at-large spots. Page 6

■ University of California and California State University systems face dramatic funding cuts of 11% and 9%, respectively, as a result of tightened California State budget. Page 6

COVER: F-117 stealth fighter developed by Lockheed with initial DARPA support. Photo courtesy of Air Force

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BUSINESS

Productivity in the chemical industry rose more than 7% in the second quarter and unit labor costs fell almost 4%, seeming to signal the end of the recession. Page 21

Germany's Bayer can't use its tradename in the U.S. as a result of an injunction issued by a judge in New York. Page 22

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Macroeconomic policies haven't considered environmental damage resulting from development programs for developing countries and thus are responsible for their ecological decline, charges think tank report. Page 26

Very stringent rules for pesticide registration are being considered by the European Community, but European agrochemical industries are lobbying hard to weaken them. Page 27

California's reporting system for use of agriculture chemicals, although a major challenge to implement, proves beneficial to the state. Page 28

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Some complexes of nitric oxide and a nucleophile release nitric oxide spontaneously and may prove useful for biomedical research. Page 32

Initial progress of NSF grant program to support research projects in chemistry and chemical engineering, aimed at reducing pollution at its source, is detailed. Page 33

Test of electronic version of 20 ACS journals with graphics will begin this month at Cornell University as part of a new communications collaboration. Page 34

ACS NEWS

Council acted on a number of matters at the recent Washington meeting—but no petitions this time. Page 36

NEWS FOCUS

Senate bill to modify Defense Advanced Research Projects Agency's focus to include more dual-use technologies has some agency experts worried. Page 7

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LETTERS

CHEMICAL SAFETY

Explosion with MoO_5·DMPU complex

With the discovery of the ability of the oxodiperoxymolybdenumhexamethylphosphoramide complex (MoOPH) to oxidize enolate anions to α-hydroxy ketones [*J. Am. Chem. Soc.*, **96**, 5944 (1974); *J. Org. Chem.*, **43**, 188 (1974)] has come widespread use of this reagent. More recently, James C. Anderson and Stephen C. Smith, in an effort to replace the toxic HMPA ligand, have recommended its substitution by the noncarcinogenic 1,3-dimethyl-3,4,5,6-tetrahydro-2-(1*H*)-pyrimidinone (DMPU) [*Synlett*, **2**, 107 (1990)]. Indeed, in our experience, this modified reagent, for which the acronym MoOPD has been proposed, is entirely comparable to MoOPH in its efficacy. The two reagents are prepared similarly. In the latter case, MoO_3 is treated with 30% H_2O_2 at 40 °C, cooled to 10 °C, and complexed to 1 equivalent of DMPU. The resulting solid, MoO_5·DMPU·H_2O, is recrystallized from methanol at 40 °C, and dehydrated at 0.5 torr over P_2O_5. The resultant solid is then dissolved in tetrahydrofuran and treated with 1 equivalent of pyridine to give MoOPD.

Recently, we had occasion to transfer the dried MoO_5·DMPU (about 70 g) into a round-bottomed flask in preparation for its dissolution in THF. This transfer had been performed many times before without incident. On this occasion, the student attempted to facilitate passage of the solid through the attached funnel with a stainless steel spatula. A violent explosion resulted with complete destruction of the glassware. The operator received extensive cuts to his face, arms, and torso. The safety glasses he was wearing clearly prevented damage to his eyes.

Oxodiperoxy complexes should therefore be invariably treated as shock-sensitive materials and handled behind appropriate safety equipment.

Leo A. Paquette
Dongsoo Koh
Ohio State University

Mercury vapor release from Kjeldahl digests

We would like to comment on David Lewis' letter (C&EN, Aug. 10, page 2) concerning mercury vapor release from Kjeldahl digests during distillation. It should not be surprising that this occurs, because a sodium thiosulfate-sodium hydroxide mixture under elevated temperature would certainly contribute to mercury metal formation. The surprising aspect of Lewis' comments is that the standard procedure continues to require mercury salts at all.

A large number of mercury-free catalyst preparations, which are composed of nontoxic components, are commercially available. In most cases, the preparations consist of a transition metal (usually a copper salt), an organic matrix decomposing agent (peroxides or titanium dioxide), and potassium sulfate (for boiling-point elevation). Our experience with the mercury-free systems is that they yield better recovery of total nitrogen with shorter digestion times compared with the mixtures that contain mercury metal or mercury salts. In fact, our direct experience with the determination of nitrogen in polyvinylpyrrolidone (a pharmaceutical excipient) has resulted in the change of the official U.S. Pharmacopeia monograph procedure to incorporate the use of a $CuSO_4$-TiO_2-K_2SO_4 catalyst mixture. We strongly suggest that Lewis alert the Environmental Protection Agency to the safety hazards associated with the standard test and recommend use of a mercury-free preparation. Although correlation data will certainly be required to confirm the validity of the modified test, such a test will be infinitely safer to use and will most likely have faster digestion times.

Robert M. Ianniello
Section Manager, Analytical Department
International Specialty Products
Wayne, N.J.

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Major Change in Offing for DARPA, Key Defense Research Agency

If Congress has its way, the Defense Advanced Research Projects Agency will be directed to pursue more dual-use technologies

Lois R. Ember, C&EN Washington

In 1958, the Soviet Union launched Sputnik and sent a technologically surprised U.S. into a tailspin. Sputnik's unexpected existence sparked scientific and technologic revitalization in the U.S. civilian and defense sectors. Earth's first man-made satellite, in particular, spawned a small, still little known, but highly innovative agency, now called the Defense Advanced Research Projects Agency (DARPA).

DARPA is the Department of Defense's (DOD) pivotal research and development organization. Sen. Jeff Bingaman (D.-N.M.) calls it "the crown jewel in the defense research establishment, and one of the most successful agencies in the entire federal government." But the jewel is sparkling less brightly these days, and Bingaman is offering legislation to polish it up.

Simply stated, the agency is charged with making certain that the U.S. never again faces a technological bombshell, and that the individual armed services are equipped with the most sophisticated, state-of-the-art communications and weapons systems. DARPA director Gary L. Denman describes the agency's mission as "exploring the limits of the possible." He proudly notes that "almost every weapons systems that was used [in the Persian Gulf War] could trace its origin to DARPA."

DARPA's most recent formal mission statement calls for it to conduct "imaginative and innovative R&D projects offering significant military utility." Moreover, the statement directs the agency to be daring and risk-taking. Basic and applied R&D projects should "exploit scientific breakthroughs and demonstrate the feasibility of revolutionary approaches for improved cost and performance of advanced technology for future applications."

However, some believe DARPA has been asked to interpret its mission too narrowly, excluding—to the impairment of DOD and the nation—work on dual-use technologies that have high potential utility in the commercial, as well as military, sector.

Denman: agency explores limits of possible

Once DARPA was renowned for being ahead of the curve in solving exotic problems. Historically, it has strongly influenced technological developments in the civilian sector. Commercial spin-offs of its work have included the computer mouse, packet switching that allows more than one personal computer to be used in the same network, and new lightweight composite materials used in skis and tennis rackets.

But in recent years, DOD has gone from being a leader in advancing technology to a follower. It has become increasingly dependent on developments in the civilian sector. However, because of its management style and contracting procedures, DOD has found it more and more difficult to gain access to developments in the civilian sector.

Lewis M. Branscomb, director of a science policy program at the John F. Kennedy School of Government at Harvard University and former chief scientist at IBM, calls this trend the ghettoization of the defense establishment. He argues that, to its detriment, the U.S. has developed two separate technological cultures: one military, the other civilian. But, "as the defense budget declines, the government will become more dependent on access to an increasingly sophisticated commercial high-tech industry. This suggests that commercial and defense programs need to share a common technological base," he says.

To prevent a downward spiral in national security, and to bolster economic competitiveness, Bingaman has introduced a bill designed to "integrate defense and commercial technologies into a strong, unified, national technology base." His bill would accomplish this by expanding DARPA's charter to focus more heavily on dual-use technologies without sacrificing agency support for technologies of purely defense importance.

Bingaman and his supporters contend that dual-use technologies—electronics, software, new materials—are becoming a major factor in basic technologies crucial to the military. These very same technologies are also central to economic

Military, civilian sectors target similar technologies. . .

MILITARY (Defense Department)	CIVILIAN (Commerce Department)
Composite materials	Advanced materials
Machine intelligence and robotics	Artificial intelligence
Software productivity	High-performance computing
Data fusion	Digital imaging technology
Photonics	Optoelectronics
Semiconductor materials, advanced semiconductor devices	Microelectronic circuits
	Biotechnology
Biotechnology materials and processes	Superconductors
Superconductivity	Sensor technology
Passive sensors	

. . .but cultures of the two show dissimilar traits

IMPETUS FOR DESIGN

Civilian: Market-driven, opportunistic introduction of new products
Military: Dictated by military requirements

NATURE OF RESPONSE

Civilian: Rapid, incremental improvements, punctuated by more basic redesigns
Military: "Big leap" improvements

PRODUCT CYCLE

Civilian: Measured in years
Military: Measured in decades

PRIORITIES

Civilian: Process technology for low-cost manufacturing, high quality, flexibility
Military: Product technology for functional performance, long shelf life

PRODUCTION

Civilian: High production rates and volumes
Military: Low production rates and unit volumes

INTEGRATION OF R&D WITH PRODUCTION

Civilian: Integrated management of R&D, production, customer service
Military: R&D and production separately contracted for, sequential

TECHNOLOGY SHARING

Civilian: Success based on proprietary technological advantage
Military: Success may require sharing know-how with second-source contractor

Source: G. L. Epstein and A. B. Carter in "New Perspectives for a Changing World Order," American Association for the Advancement of Science, 1991

competitiveness in a world where leading-edge technology is likely to be developed in the private sector and probably outside the U.S.

As Bingaman notes, "Even though defense and commercial products continue to diverge from one another, the supporting technologies are converging." By fostering dual-use technologies, DOD probably will gain faster and cheaper access to commercial technology. And the civilian sector will likely benefit from additional federal support.

The Senator's bill, S. 2517, has been approved by the Senate Armed Services Committee as part of the fiscal 1993 defense authorization bill, which at press time was being debated on the Senate floor. There are no provisions for expanding DARPA's mission in the already-approved House version of the authorization bill, but the Bingaman provisions will likely be accepted by the House-Senate conference committee for inclusion in the final fiscal 1993 defense spending bill, says Edward McGaffigan Jr., a Bingaman aide.

As now constituted, DARPA is a lean, mean research machine that insists on taking the long view with a "focus on scientific breakthroughs and revolutionary approaches," director Denman explains. It vigorously and consistently pursues concepts that change in very fundamental ways how military systems work. This contrasts sharply with the research programs of the Army, Navy, and Air Force, which generally strive for incremental changes to existing military systems.

With annual budgets hovering around $1.5 billion, DARPA is in a unique position of being "a very small fish in a very large pond," says Gerald L. Epstein, coauthor of the recently published book, "Beyond Spinoff: Military & Commercial Technologies in a Changing World." Although its budget is quite large compared with budgets for similar activities in the Commerce Department, for example, Epstein points out that DARPA's budget is less than 1% of the Pentagon's, its parent agency.

Because its budget amounts to mere paper-clip money for the Pentagon, DARPA has been able to operate fairly autonomously. "It's had the freedom to explore technologies that had no immediate application, without having a spotlight focused on every decision it has made," Epstein explains.

This freedom has even allowed the agency to underwrite the development of new industries, as it did with computers. It was an early and generous supporter of leading-edge R&D in the commercial computer industry for a very simple reason: The Pentagon, a major user of computers, would benefit as a purchaser of state-of-the-art products rapidly being developed in the commercial sector.

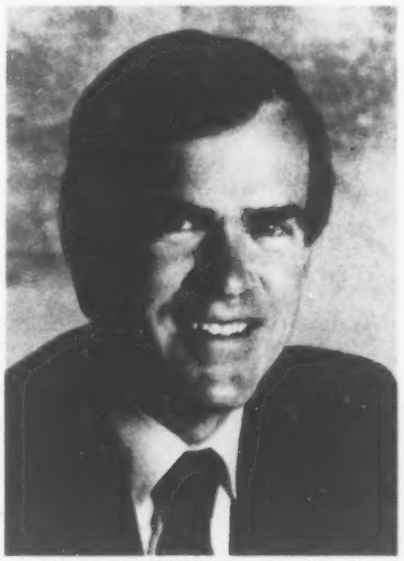
Although it sponsors path-breaking research, DARPA's 148 personnel do no research themselves. All projects are contracted out to industry and academic laboratories. And what makes the agency unique is that it is a self-contained contracting entity unburdened by the typical bureaucracy of other government contracting agencies. Emphasis is on speed, so the contracting process is unusually flexible and creative.

There are 10 technical offices within DARPA, each with its own director. These office directors report to DARPA director Denman, who in turn reports to Victor H. Reis, director of defense research and engineering and the immediate former head of DARPA. Denman is a civilian, chosen by the Secretary of Defense.

The key to DARPA's successful track record is the agency's 86 program managers who report to technical office directors. These 86 scientists and engineers ride herd on the

cutting-edge basic and applied R&D projects that have produced the stunning technical breakthroughs for which the agency is noted—stealth technology that makes the F-117 fighter nearly invisible to radar, revolutionary new materials, and massively parallel computers. They plan research programs, award and manage project contracts, solicit promising ideas from industry and university sources and propose these ideas to agency directors, and keep current on the latest developments in their fields.

The agency is not afraid to pursue what McGaffigan calls "wacky, but often fruitful ideas," but it does not pursue them indefinitely. Depending on the technology, DARPA will give a concept three to 10 years to prove out. If a technology fails to pan out, DARPA drops it and moves on to the next tantalizing possibility.



Bingaman: DARPA is crown jewel

Contracts are awarded on a competitive basis. Frequently DARPA will pair research teams from industry and academia, on a cost-sharing basis, to bring an emerging technology to the prototype stage. DARPA's ultimate customers are the armed services, which often must be prodded from their parochial perches to be convinced of the need for, and effectiveness of, path-breaking technologies.

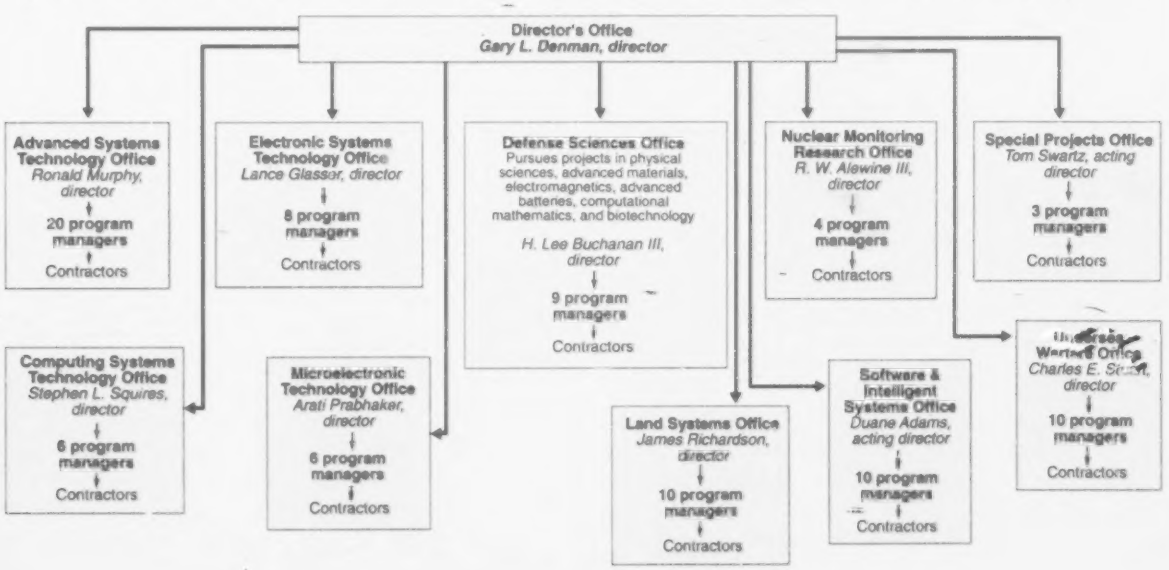
For the near future, the agency's R&D endeavors will focus on electronics, information technology, materials, and propulsion. Prime areas of emphasis in electronics include optoelectronics and electronic devices based on the so-called quantum-well phenomena, and high-temperature superconductivity.

The agency expects optoelectronics will offer novel interconnections for massively parallel computers (computers working separately but simultaneously, each on one part of a single problem), high-definition displays (the commercial version is high-definition television), and image processing free of electromagnetic interference. Quantum-well devices are expected to form the basis for ultrafast computing in the next century. Passive microwave components made from unique ceramic materials—the products of high-temperature superconductivity research—have already been inserted into existing electronic warfare systems.

According to Bingaman, "DARPA almost single-handedly created the discipline of materials science." Renee Ford, *Materials & Processing Report* editor, confirms that "DARPA was one of the most significant early and sustained supporters of all the major areas of materials science." Ford particularly cites the agency's support for research on the chemical laser and the chemical basis of ceramics.

DARPA's advanced composite materials program aims to produce lightweight, structurally sound materials able to

Key to DARPA are 86 program managers—nine oversee physical science, biotech projects



operate in the high-temperature environments of jet engines, airframes, and missiles. Research on electronic materials has produced gallium arsenide, indium phosphide, and mercury cadmium telluride for high-speed signal processing and infrared imaging.

Even objects as mundane—though necessary—as batteries have been given the DARPA spin. By exploiting a breakthrough in the chemistry of conducting polymers, the agency has been able to build a pilot line for producing solid-state batteries with very high power density. The pilot line is producing these batteries using a continuous thin-film manufacturing process. According to Denman, the batteries can be recharged, have 100 times the shelf life of nickel-cadmium batteries, and are safe. They do not explode when heated, punctured, or short-circuited. They also can be molded into shapes that fit specific weapons systems.

Ep[illegible] spotlight on agency decisions

DARPA research in the area of high-performance computing is extensive, and the agency is a key player in the federal high-performance computing and communications program. Computing systems (and their supporting software) fundamental to the information revolution are on or just over the horizon. Gigaop systems, using 100 billion operations per second, are now emerging, and two such systems are ready to hit the commercial market, Denman says. Teraop systems, using 1 trillion operations per second, are expected by the mid-1990s.

Most recently, the agency has effected a major basic change in high-performance computing by developing scalable parallel computing. That didn't happen serendipitously. The agency has been developing and advancing computing technology since 1961, and has been responsible for such changes as time-sharing, computer graphics, computer networking, and personal computing.

To ensure that it has the materials and equipment for the manufacture of electronic components critical to defense, DARPA provides 50% of the operating funds for the nonprofit consortium called Sematech. Fourteen U.S. semiconductor firms and the more than 150 suppliers that compose Sematech provide up to 80% of the integrated circuits used in weapons systems.

This year, DARPA set up another seven cost-sharing consortia. The intent is for the Pentagon to share the financial burden with industry for military-critical technologies that neither the Pentagon nor industry wants to fund alone. DARPA has $60 million that it can apply to these consortia, which are positioned to develop technologies ranging from microelectronics for "smart" weapons to so-called stealth-measuring algorithms.

For various reasons, few expect that the agency will be able to duplicate its past success rate. According to Bingaman, a key factor to DARPA's earlier successes "was the agency's ability to fund visionary research with only indirect military applications." In its prime, DARPA project managers made commercial spin-offs a conscious objective.

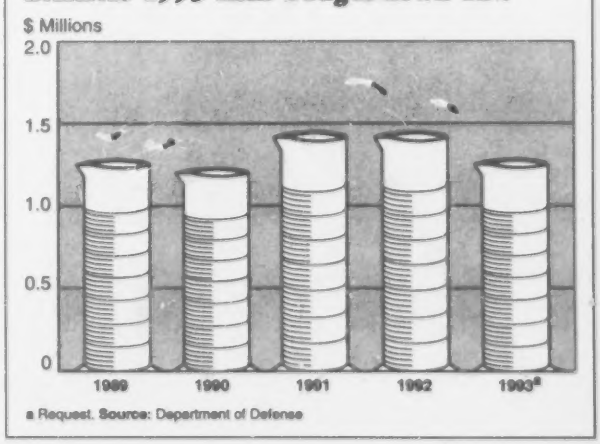
During the past two decades, however, budgetary distress has pressured the agency to focus on less visionary, more immediate applications and engineering. And in the past four years, free-market advocates in the industrial-policy shunning Bush Administration have decided that "DARPA should not support any technology with significant commercial application," Bingaman contends. The end result is predictable: "Support for dual-use technology has gone from being an ideal to a pejorative."

Several eminent groups have traced what they see as the U.S. decline in national security and economic prosperity to the government's disinterest in pioneering and fostering dual-use technologies. One such group, the Carnegie Commission task force headed by retired Admiral Bobby R. Inman, provided the basis for Bingaman's legislation.

The 1991 Carnegie report, "Technology & Economic Performance: Organizing the Executive Branch for a Stronger National Technology Base," concluded that "the Department of Defense and other federal agencies should have programs that enable their technology developments to serve commercial industry as well."

The Carnegie task force recommended DARPA be converted into a National Advanced Research Projects Agency (NARPA) that would more tightly link military needs and high-tech industry. Although retaining its main responsibility of servicing its key clients—the armed services—NARPA would help to create a national technology base, one that merged the now separate military and civilian technology bases. "Separate enclaves serve neither the commercial economy nor national security," the report concluded. Further, the commission urged that NARPA support

DARPA's 1993 R&D budget down 12%



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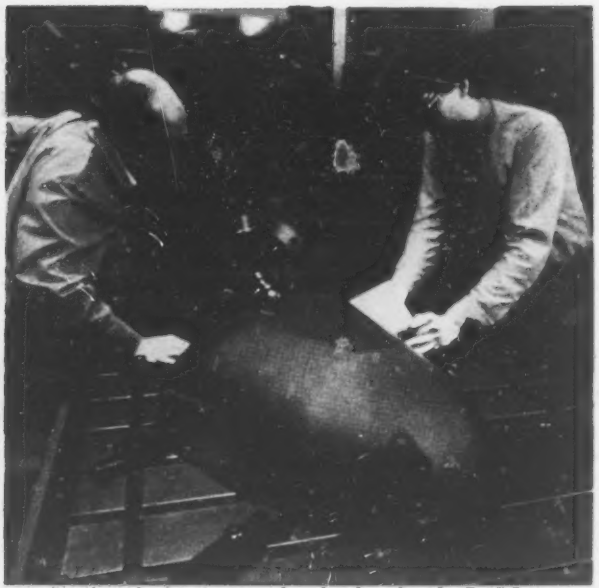

Reinforced ceramics, metals—developed under DARPA contract by Lanxide—are used in armored vehicle hatches

dual-use technologies as well as long-term, high-risk, generic technologies that have potentially high pay-offs.

A 1992 study by the National Academy of Sciences (NAS), "The Government Role in Civilian Technology," supports the Carnegie findings, urging "that DARPA's traditional role in dual-use technology be reaffirmed." The NAS task force, chaired by Carter Administration Defense Secretary, Harold Brown, stresses that the panel is not calling on DARPA to focus on technology developments that have strictly commercial applications.

In addition, Epstein's book, "Beyond Spinoff," warns that "the Pentagon cannot provide the best technology to the military services unless it breaks out of its enclave, learning to use technology spawned in the commercial sector and attracting capable high-technology firms willing to supply its needs."

Bingaman asserts DARPA is a prime, though not the only, mechanism for helping the nation regain its economic competitiveness and maintain its defense superiority. "DARPA's traditional operating style is well suited to a post-Cold War era in which DOD must increasingly access commercial technology and work with commercial firms." Bingaman adds that the agency has been relatively immune to Congressional micromanagement. "There has not been pressure on DARPA to support the politically powerful as opposed to the economically promising."

The legislation he has offered drops the word defense from DARPA's name, giving it back the name it had during its first 14 years of existence, but keeps ARPA within DOD. As envisioned, ARPA would continue to support technologies having unique military applications, but would direct increasing attention to development of dual-use technologies.

It would do this by reaching out to companies that have not traditionally worked with the Pentagon. To make this possible the bill would have ARPA work more collaboratively with these nondefense firms through the medium of cooperative agreements. Presently, DARPA uses contracts as the legal means of supporting research. And through these contracts, DARPA controls almost every decision about project management and technical objectives.

Bingaman says his bill does not dilute DARPA's military mission. "ARPA would remain a defense agency, connected to the needs of its defense customer, and subject to the authority, direction, and control of the Secretary of Defense." Further, he says, "the agency will continue to fund purely military R&D and continue to serve as the 'court of last resort' for leap-frog military technologies that the individual services choose not to fund."

He stresses that ARPA would not undertake research projects having purely commercial application, or "broaden its research purview to technologies without a potential military application." ARPA's defense mission would come first, but that mission would "require a national technology base."

Bingaman emphasizes that ARPA's existence would not "preclude the expansion of the Commerce Department's Advanced Technology Program, or the creation of other, ARPA-like entities in civilian agencies." In fact, he supports the NAS task force's call for the establishment of a $5 billion Civilian Technology Corp. (CTC), to be funded through a one-time Congressional appropriation. The thrust of CTC would be to increase commercialization of new products and processes. Under the CTC umbrella, the government would support precommercial technologies by creating joint ventures with private industry. By using CTC as a conduit, the NAS task force argues, there would be no interference with corporate management strategies or with market forces that drive economic growth.

Beltz: success will be undercut by dual-use push

Bingaman aide McGaffigan wants the thrust of the Senator's bill to be very clear: "We are saying that DARPA has an appropriate role in dual-use, generic, precommercial technologies in its areas of competence. We are not saying that DARPA should get more involved in the commercial sector than it has in the past, or get involved in areas that it has not traditionally been involved in, like environmental R&D."

There is now an "opportunity for synergy between the commercial and military sectors. And we should seize it," McGaffigan says.

Research chemist transforms idea into device with DARPA support

Imagine the memory capacity of a Cray supercomputer in a device the size of a sugar cube. University of California, Irvine, chemist Peter M. Rentzepis did. And along with engineering colleagues at the University of California, San Diego, he obtained funding from the Defense Advanced Research Projects Agency (DARPA) to transform his creative musings into a concrete 3-D memory cube—1 cm on each side—that one day will be capable of storing 1 trillion bits of information.

Not only is the memory device capable of storing a lot of information, it "has the potential of writing and reading billions of bits of information in thousandths of a second," Rentzepis says. Furthermore, it is easy to build and inexpensive.

The concept behind the 2-photon 3-D memory cube is beguilingly simple. A laser beam is split in two. Mirrors and lenses direct the two beams so that they intersect at right angles on one photochromic molecule within the cube. The combined energy of the two beams is absorbed by the light-sensitive molecule, changing it from colorless to blue. In computer language, using 0 and 1, this "write" molecule goes from a 0 bit to a 1 bit.

To read the stored information, another laser of a different wavelength is split in two, and made to intersect on the altered write molecule. The combined energy of the laser beams is absorbed by the blue molecule, causing it to fluoresce and emit a red light. Photodetectors sense the red flashes from this "read" molecule, and if the detectors are linked to a computer processor, the flashes can be converted back into bits of information.

Right now the patented experimental memory device consists of a polystyrene cube into which photochromic molecules have been dispersed. The light-sensitive molecule Rentzepis is currently using is a spirobenzopyran that goes by the moniker 5'-chloro-6-nitro-1',3',3',-trimethyl-spiro-[2*H*-1-benzopyran-2,2'-indoline]. However, as the device is further researched and engineered, it is very likely the polymer matrix and the photochromic molecule will change.

Rentzepis and colleagues have shown that their experimental system works. A few bits of information have successfully been written, read, and "erased." But a lot more work needs to be done to transform the experimental device into a prototype that eventually can go into full-scale production.

One vexing problem is the stability of the spirobenzopyran in the written form—at room temperature it is retained only for minutes and in dry ice only for days. There appear to be at least two ways of solving this problem. "You could anchor the ends of the open read form" of the spirobenzopyran, "or you can look for new types of molecules such as intermolecular proton transfer molecules," Rentzepis explains.

Combining his many years of research on lasers with his more recent interest in optical computing enabled Rentzepis to make the intuitive leap

However, DARPA officials don't appear ready to do so. The agency's only official statement on the ARPA legislation comes from former director Reis. He told a Senate Armed Services hearing in April, "I believe that increasing the scope of DARPA beyond its current mission ... as suggested by the Carnegie Commission will have a negative effect upon DARPA and its role." Bingaman largely based his ARPA legislation on the recommendations of this commission.

At a recent symposium on defense R&D and competitiveness, sponsored by the American Enterprise Institute (AEI), a Washington-based public policy think tank, a panel discussing DARPA's future mission agreed "that there is nothing that should prohibit DARPA from pursuing those technologies that are being driven by a clear military mission. And if there are commercial spin-offs, then that's fine, but that shouldn't be the up-front consideration," says AEI policy analyst Cynthia A. Beltz, who organized and participated in the symposium.

Panel member Theodore H. Moran, director of international business at Georgetown University, tells C&EN he is "not adamantly against expanding DARPA's role into dual-use targeting. But if we do so, we should permit foreign companies to be eligible to participate in DARPA's programs on a cost-sharing basis." That said, Moran still believes "a better way of strengthening civilian R&D, by far the more efficient and cost-effective way, is to expand the R&D credit."

Another panel member, David C. Mowery, professor of business administration at the University of California, Berkeley, tells C&EN "DARPA has been successful because it has been a small, lean agency with little middle management that has focused on a narrow profile of technologies. The danger it faces under the proposed legislation is being asked to fund programs in a much broader array of technologies."

Mowery insists that "DARPA is not the appropriate agency for the mission of improving economic competitiveness." Baker Spring, defense policy analyst at the Washington-D.C. based Heritage Foundation agrees: "DARPA is primarily a defense agency, and its mission is to put the best technology in the hands of fighting men. It should not be sidetracked into commercially competitive technologies if it comes at the detriment of its military mission." The mission for ARPA as outlined in the Bingaman bill "symbolically moves away from a focus on defense technologies, and that's ill-considered," Spring says.

Beltz contends that "the capabilities that made DARPA successful in

DARPA invests heavily in chemically related research

$ Millions	1993[a]	1992	1991
Materials science	$31.8	$42.7	$16.2
High-temperature superconductivity	22.7	26.5	25.3
Materials processing	18.2	78.9	57.2
Optoelectronics/ gallium arsenide	15.2	14.7	10.2
IR crystal growth technology	0	0	10.0

a Requested. Source: Department of Defense

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Rentzepis with prototype of memory cube device

from 2-D storage on magnetic disks to the theoretical possibility of more powerful 3-D storage in a plastic cube embedded with light-sensitive material. The much honored, 55-year-old chemist could have sought and probably would have received support to prove out his concept from several sources. But when he did seek support, Rentzepis went to DARPA, not the National Science Foundation.

He did so for several reasons, one being amount of support. DARPA has funded him to the tune of $1.5 million over three years, a contract that is coming to a close. This is more than NSF would have given him, he says.

Furthermore, NSF supports and encourages very basic science as an end in itself. DARPA, on the other hand, supports basic research but with the objective of some day having a viable, defense-related product. In Rentzepis' case, that product will be a computer storage device that will not be the rate-limiting factor in powerful optoelectronic computers and highly parallel electronic processors still to be developed.

"I'm not suggesting that basic science is not useful," Rentzepis contends. "But it is nice to see your own work becoming useful in your lifetime."

He and his San Diego collaborators have high expectations that their memory device contract will be renewed for another three years, allowing them to develop a prototype. Another DARPA contract under which Rentzepis "built what I think is the first picosecond x-ray lab system," has already been extended for one year.

Rentzepis has enjoyed doing basic, nonclassified research under DARPA contracts. "DARPA gives a sufficient amount of money [for carrying out the research], but is demanding, and I think that is right. The agency keeps close track of deadlines and the project as a whole," he explains.

DARPA is doing a vast amount of materials research. Because of this, Rentzepis "thinks it can be a good research home for a lot of chemists."

the past will be undercut by the push to dual use." Furthermore, she argues, "the agency was successful because it had a narrow agenda, and was a small, flexible agency with a great deal of independence. This independence could be jeopardized by increasing micromanagement by Congress. Dual use could be the mandate that opens the door for Congress to intervene in DARPA's internal decisions. It could be the back door for a wider competitiveness agenda." Moran expresses a similar concern: "I am wary that [the Bingaman bill] opens the door to pork-barrel Congressional pressures."

At the symposium, McGaffigan said that that wasn't a concern because DARPA in the past has been insulated from Congressional interference. But Beltz argued that "Congress has micromanaged DARPA by giving it *x* amount of dollars for *y* technologies." To which McGaffigan countered that Congress may have picked the technologies and the amount of support, but DARPA chose the projects and contractors.

Beltz's bottom line is simple. "The legislation in itself is not controversial." But she is not convinced that it will "work in practice in the tidy and measured manner proponents say it will, and not become a stalking horse for projects Congress wants, but the Defense Department doesn't."

She wonders if "it is realistic to expect DARPA to play the same role in the future as it did in the sixties as a technology incubator when we're in a world that is clearly 'beyond spin-off.' " What she is alluding to is the flow of technology from the civilian to the defense sectors, when in the past the flow was in the reverse direction.

"Beyond Spinoff" coauthor Epstein suggests "DARPA should not be the single government agency operating on civilian technologies." It is very possible, he points out, that the agency "may not be the vehicle for reaching the broad spectrum of industrial projects" that may be needed to promote global economic competitiveness, and that programs within the Commerce Department may provide the better route.

As DARPA moves toward the mission proposed for ARPA, "it may be less able to operate autonomously, as it has in the past, and it will certainly have to interact more closely with industry," Epstein says. "The risk for tighter Congressional oversight is real. There is a need to come up with some insulation that will allow the agency to retain its autonomy yet still have close contact and consultation with industry."

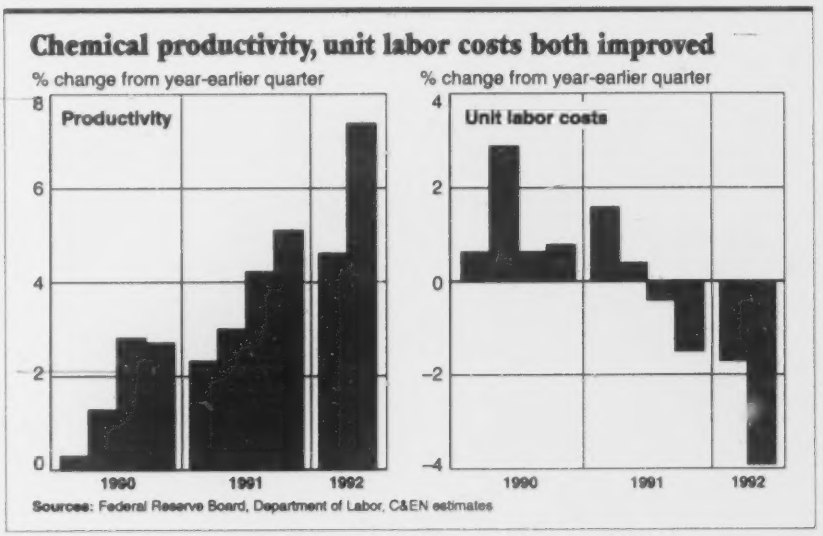
"I am almost certain that there is not a single institutional solution" for promoting both military security and economic prosperity, Epstein adds.

Despite all the qualms expressed, supporters of an expanded DARPA mission, like Ford, ask: "Why shouldn't we take advantage of projects DARPA has supported that have benefits for the civilian sector? Why shouldn't we get more bang for the buck?" These are the very questions addressed by Bingaman and his Congressional supporters.

Surprisingly, for a macho defense-oriented agency, DARPA is often described in such maternal terms as "technology incubator," and "nurturing environment." The consensus in Congress at the moment is that DARPA now needs to extend its protective mantle around dual-use technologies. □

Chemical Productivity Jumped In Second Quarter

■ ***Increase of more than 7%, largest in years, was far better than that for all manufacturing; unit labor costs fell 3.9%***



A sharp rise in productivity in the second quarter seems to signal a post-recessionary period for the chemical industry. Typically, at or near the end of a recession, productivity rises quickly as increases in work forces, which were pared during the contraction, lag increases in output. The result is more units of product produced by fewer workers.

For instance, chemical productivity in 1983 climbed more than 8% over the previous year, marking the end of the early 1980s' recession. Similarly, productivity in the chemical industry jumped more than 10% in 1976 over that for 1975, the year in which the 1970s' recession ended. Productivity is defined as output per unit of labor, calculated by dividing the Federal Reserve Board's index for production by the Labor Department's index for aggregate weekly hours of production.

Productivity in the chemical industry, according to calculations by C&EN based on data from the Federal Reserve Board and from the Labor Department, increased 7.4% in the second quarter over the same period in 1991 to an index of 115.0 (1987 = 100) and was up 3.5% over the first quarter this year. This is far better than the productivity increase for the total manufacturing sector. Productivity for all manufacturing rose only 1.2% in the second quar-

Second-quarter productivity improvement better for chemicals than for all manufacturing

	1992		1991				1990			
	2nd qtr	1st qtr	4th qtr	3rd qtr	2nd qtr	1st qtr	4th qtr	3rd qtr	2nd qtr	1st qtr
CHEMICALS AND ALLIED PRODUCTS										
Production	116.9	113.6	113.2	112.1	109.3	109.1	109.9	110.8	109.9	110.0
Workhours	101.0	101.6	101.3	101.0	101.4	102.1	103.4	104.0	105.0	105.3
Productivity	115.0	111.1	111.1	110.3	107.1	106.2	105.6	105.9	104.0	103.8
Hourly production wages	116.6	115.3	115.2	114.1	113.0	112.1	111.2	110.0	109.3	107.9
Unit labor costs	101.3	103.7	103.7	103.4	105.5	105.5	105.3	103.9	105.1	103.9
ALL MANUFACTURING										
Production	109.3	108.0	108.6	108.5	106.7	106.1	109.0	111.1	110.2	109.2
Workhours	102.9	102.6	102.5	102.5	101.7	102.1	104.4	107.4	108.0	108.1
Productivity	114.0	112.9	113.7	113.6	112.6	111.5	112.0	111.0	109.5	108.4
Hourly production wages	115.5	114.3	114.2	113.3	112.5	111.5	111.1	109.9	109.1	107.9
Unit labor costs	101.3	101.2	100.5	99.8	99.9	100.0	99.2	99.0	99.6	99.5

Note: Productivity is output per workhour, calculated by dividing indexes for production by indexes for workhours of production employees. Unit labor costs are labor costs per unit of output, calculated by dividing indexes for wages by indexes for output per workhour. **Sources:** Federal Reserve Board, Department of Labor, C&EN estimates

ter to an index of 114.0 and was up less than 1% from the first quarter of this year.

The year-to-year productivity increase for the chemical industry in the second quarter, the largest in years, came on a 7% rise in chemical production over the year-earlier quarter. Workhours, which have trended downward since mid-1990, continued to decline, although at only a slight 0.4% from the previous year's second quarter.

One of the major reasons for the decline in workhours over the past two and a half years has been the cutback in employees at chemical companies (the index of aggregate workhours is a function of both the number of workers and the hours worked). Since the beginning of 1990, according to the Department of Labor, the number of production and nonsupervisory workers has fallen about 36,000, or almost 6%, on a seasonally adjusted basis. And for the first half of that two-and-a-half-year period, production was for the most part relatively flat, prior to picking up in mid-1991. Thus, since the second half of 1991, production has increased and the number of plant workers has continued to fall, increasing productivity on even its most basic level—the number of workers needed to turn out a particular product.

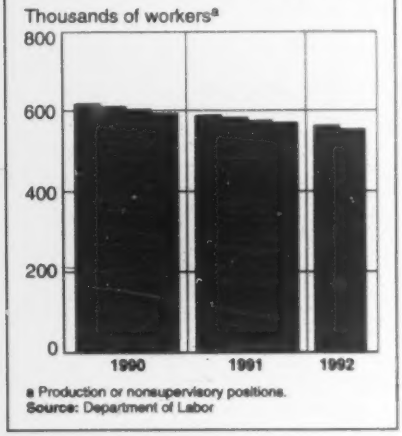
Like productivity, unit labor costs (the employee cost per unit of product) improved dramatically in the second quarter, falling 3.9% from second-quarter 1991 and down 2.3% from the first quarter this year. In contrast, unit labor costs for all manufacturing in the second quarter rose 1.4% from the year-earlier period and were essentially unchanged from this year's first quarter.

For all manufacturing, the second-quarter increase in unit labor costs came largely from a 2.7% increase in hourly production wages from second-quarter 1991 and a 1.0% rise from first-quarter 1992. The annual increase in wages thus far has outpaced the 1.2% rise in output per hour from last year's second quarter and was about the same as the 0.9% rise from the first quarter this year.

The improvement for chemicals, however, was due entirely to the 7.4% rise in productivity, which far outpaced the 3.2% increase in hourly production wages on a year-to-year basis. The increase in production wages in the second quarter was the lowest on a quarterly basis in the past two and a half years, with the exception of the 2.9% increase in the first quarter of this year.

William Storck

Rolls of chemical production workers down 6% since 1990



a Production or nonsupervisory positions.
Source: Department of Labor

Bayer barred from using tradename in U.S.

With the stroke of a pen, a judge in New York has essentially made Germany's Bayer—the fourth largest chemical producer in the world—into a noncompany in the U.S.

A U.S. District Court judge for the Southern District of New York has issued a final injunction that prohibits Bayer A.G. or any of its subsidiaries from referring to the Bayer trademark name in the U.S. in any but the most restricted circumstances. The injunction not only limits Bayer's use of the name in the U.S., but also restricts the use of the name outside the U.S. where advertisements or news reports originating from Bayer or its affiliates overseas may make their way into the U.S. market.

The injunction leaves the German chemical producer, which had $25.5 billion in worldwide sales in 1991, bereft of its identity in the U.S., where, under its U.S. operating company Miles Inc., it has annual sales of nearly $6.2 billion. It also shatters the results of the company's negotiations in 1986, with a payment of $25 million to Sterling Winthrop, to reestablish limited U.S. rights to the use of its name.

Bayer originally lost use of its trademark name and cross following World War I when the U.S. government confiscated Bayer's U.S. assets as alien property and sold the Bayer trademark name, Bayer cross, and aspirin business to what is now known as Sterling Winthrop, Eastman Kodak's pharmaceutical subsidiary.

District Court Judge Robert J. Ward's final injunction followed a trial concluded in July 1991 and a decision this May in which he ruled that the German chemical company had been using the Bayer name in the U.S. in violation of agreements with Sterling Winthrop. These agreements restricted Bayer's use of the name to nonconsumer, nonpharmaceutical identifications.

"The judgment really limits our freedom of action worldwide," says a Miles vice president of corporate communications, Barry S. Cohen. "We do not think the judgment is legally sound. It probably has some freedom of speech implications as well." He adds that Miles is in the process of appealing the judge's ruling. A Sterling Winthrop spokesman says that because of the appeal, his company has no comment.

In the meantime, Cohen says Miles is complying with the judge's injunction, effectively obliterating the Bayer name, by recalling and replacing any promotional items having the Bayer name that may still be in U.S. facilities. The injunction also has affected the manner in which parent Bayer A.G. recently released second-quarter earnings in Germany. Press material contained the warning that Bayer information was not for release in the U.S.

Bayer saw the handwriting on the wall a year ago in September when, in anticipation of the final injunction, it said it would jettison the Bayer USA name for its holding company and establish a new operating entity for all U.S. operations under the name of Miles. At that time, Helge H. Wehmeier, president and chief executive officer